

Epidemiology

Course
Pathophysiology

Unit VI
Epidemiology

Essential Question
How is data gathered to track an outbreak of a disease?

TEKS
§130.208 (c)
(7) (A) (D) (E)

Prior Student Learning
Infectious Diseases and Microbial Agents

Estimated time
4-5 hours

Rationale

Epidemiology is considered the basic science of public health.

Objectives

Upon completion of this lesson, the student will be able to

- Define epidemiology
- Explain the basic steps epidemiologists take when investigating an outbreak
- Identify the variety of evidence that epidemiologists must collect to determine the origin, infectious agent, and route of transmission of an infectious disease
- Investigate instances of disease using epidemiological principles
- Write an epidemiological report

Engage

Dust all handouts with Glow Germ prior to class and pass them out at the beginning of the class. Begin your lesson and, before the bell rings, announce that there has been a recent pink eye outbreak in the classroom. Demonstrate how contagious it is by modeling the rapid spread of the Glow Germ on the handouts. Next turn off the lights and use a black light to demonstrate the spread of the simulated virus.

Key Points

- I. Epidemiology comes from Greek words
 - A. *Epi*, meaning “on or upon”
 - B. *Demos*, meaning “people”
 - C. *Logos*, meaning “the study of”
 - D. The study of the distribution and determinants of health-related conditions or events in populations
- II. Basic
 - A. Epidemiology – the study of the occurrence, distribution, and transmission of diseases in humans
 - B. Epidemiologist – A professional who studies patterns of disease occurrence
 - C. Classifications of outbreaks
 1. Endemic – disease is native to a local region
 2. Epidemic – disease spreads to many individuals at the same time over many areas
 3. Pandemic – epidemics that affect large geographic regions
 - D. Factors influencing the spread of disease
 1. Nutrition

2. Age
 3. Gender
 4. Sanitation practices
 5. Socioeconomic conditions
 6. Lifestyle
 7. Agent
- E. Possible modes of transmission
1. Contact
 2. Droplets
 3. Airborne
 4. Food or water
 5. Vector born
- F. Prevention/containment
1. Vaccination
 2. Infection control
 3. Isolation

III. History of epidemiology

- A. Hippocrates (circa 400 B.C.) attempted to explain disease occurrence from a rational instead of a supernatural viewpoint
- B. John Graunt, a London haberdasher, published his landmark analysis of mortality data in 1662. He was the first to quantify patterns of birth, death, and disease occurrence, noting male-female disparities, high infant mortality, and seasonal variations
- C. In the mid-1800's
1. William Farr began to systematically collect and analyze Britain's mortality statistics
 2. John Snow, an anesthesiologist conducted a series of investigations in London that later earned him the title "the father of epidemiology"
- D. Epidemiology did not flourish until the end of World War II

IV. Uses of Epidemiology

- A. Population or community health assessment
1. What are the actual and potential health problems in the community?
 2. Where are they?
 3. Who is at risk?
 4. Which problems are declining over time?
 5. Which ones are increasing or have the potential to increase?
 6. How do these patterns relate to the level and distribution of services available?
 7. What factors influence the risk of disease?
- B. Individual decisions – use information to decrease personal risk factors, i.e. vaccinations for traveling

V. The Epidemiologic Approach

A. Case Definition – a set of standard criteria for deciding whether a person has a particular disease or disorder

B. Statistics and Reports

1. When physicians diagnose a case of a reportable disease they send a report of the case to their local health department
 - a. Time – when the case occurred
 - b. Place – where the patient lived
 - c. Person – the age, race, and sex of the patient
2. Health departments convert the case counts into rates which relate the number of cases to the size of the population where they occurred

C. Descriptive Epidemiology – organize and summarize data according to time, place, and person

1. Time – disease rates change over time – for example, the seasonal increase in influenza with the onset of cold weather
 - a. Time data is usually shown on a graph
 - b. Graph the rate of cases or deaths on the vertical, *y-axis* – put the time periods along the horizontal, *x-axis*
2. Place – describe a health event by place to gain insight into the geographical extent of the problem
 - a. Residence
 - b. Birthplace
 - c. Place of employment
 - d. School district
 - e. Hospital unit, etc.
3. Person
 - a. Inherent characteristics of people
 - i. Age
 - ii. Race
 - iii. Sex
 - b. Acquired characteristics
 - i. Immunity
 - ii. Marital status
 - c. Activities
 - i. Occupation
 - ii. Leisure activities
 - iii. Use of medications, tobacco, or drugs
 - d. Conditions under which people live
 - i. Socioeconomic status
 - ii. Access to medical care

D. Analytic Epidemiology – used to search for causes and effects, or the *why* and the *how*

1. Experimental – determine the exposure status for each individual (clinical trial) or community (community trial); individuals or communities are followed to detect the effects of

the exposure

2. Observational – observe the exposure and outcome status of each study participant
 - a. Cohort study – categorize subjects on the basis of their exposure and observe them to see if they develop the health conditions being studied
 - b. Case-control study – enroll a group of people with a disease (cases) and a group without the disease (controls), and compare their patterns of previous exposures

VI. Causation

- A. The cause of disease is a factor (characteristic, behavior, event, etc.) that influences the occurrence of disease
 1. An increase in factors leads to an increase in disease
 2. Reduction of factors leads to a reduction in disease
- B. Epidemiologic Triangle – the traditional model of infectious disease causation
 1. Agent – an infectious microorganism – must be present for disease to occur
 - a. Virus
 - b. Bacterium
 - c. Parasite
 - d. Other microbe
 2. Host factors – intrinsic factors influencing an individual's exposure, susceptibility, or response to a causative agent
 - a. Age
 - b. Race
 - c. Sex
 - d. Socioeconomic status
 - e. Behaviors
 - i. Smoking
 - ii. Drug abuse
 - iii. Lifestyle
 - iv. Eating habits
 3. Environmental factors – extrinsic factors affecting the agent and the opportunity for exposure
 - a. Physical factors
 - i. Geology
 - ii. Climate
 - iii. Physical surroundings
 - b. Biologic factors – for example, insects that transmit the agent
 - c. Socioeconomic factors
 - i. Crowding
 - ii. Sanitation

iii. Availability of health services

VII. Epidemiology and Disease

A. Chain of Infection

1. The reservoir of an agent is the habitat in which an infectious agent normally lives, grows, and multiplies
2. The portal of exit is the path by which an agent leaves the source host
3. Modes of transmission
 - a. Direct – immediate transfer of the agent from a reservoir to a susceptible host by direct contact or droplet spread
 - i. Direct contact
 - ii. Droplet spread
 - b. Indirect – an agent is carried from a reservoir to a susceptible host by suspended air particles, or animate (vector) or inanimate (vehicle) intermediaries
 - i. Airborne
 - ii. Vehicleborne
 - iii. Vectorborne
 - iv. Mechanical
 - v. Biological
4. Portal of entry – that by which an agent enters a susceptible host
5. Host – the individual infected with the agent

B. Epidemic Disease Occurrence

1. Level of Disease – amount of a particular disease that is usually present in a community
 - a. Sporadic – irregular pattern of occurrence, with occasional cases occurring at irregular intervals
 - b. Endemic – persistent level of occurrence with a low to moderate disease level
 - c. Epidemic or Outbreak – occurrence of a disease within an area is clearly in excess of the expected level for a given time period
 - d. Pandemic – an epidemic spreads over several countries or continents, affecting a large number of people

Activity

I. Complete an epidemiological study:

- Design a survey to determine the incidence of the flu.
- Collect data from teachers and students.
- Utilize data to develop charts and graph(s).
- Analyze data and draw conclusions. Address possible limitations.
- Disseminate results to class in an oral presentation.

II. Complete the Transmission of Pathogens Laboratory Investigation.

Assessment

Laboratory Investigation Rubric

Oral Presentation Rubric

Materials

Transmission of Pathogens Lab Investigation

- Disposable pipettes with a bulb
- Test tubes with lids
- Phenolphthalein (detecting or indicator solution)
- M HCl (stock solution for non-carriers)
- M NaOH (stock solution of the carrier)
- Safety goggles
- Lab apron
- Gloves
- Biohazard containers
- Surface disinfectant
- Paper towels

Theory of epidemiology

<http://www.uic.edu/sph/prepare/courses/ph490/resources/epilesson01.pdf>

<http://www.bam.gov/teachers/epidemiology.html>

World Health Organization – http://Who.int/home/map_ht.html

Centers of Disease and Control – <http://www.cdc.gov/>

Accommodations for Learning Differences

For reinforcement, the student will develop a timeline about a communicable disease. Include contamination, incubation, signs and symptoms, diagnosis, prognosis, and treatment.

For enrichment, the student will interview a public health professional to determine what epidemiological studies are being conducted locally and the tools being used for data collection.

National and State Education Standards

National Healthcare Foundation Standards and Accountability Criteria:

Foundation Standard 1: Academic Foundation

1.3 Medical Mathematics

1.32 Analyze diagrams, charts, graphs, and tables to interpret healthcare results.

Foundation Standard 2: Communications

2.1 Concepts of Effective Communication

2.13 Report subjective and objective information.

2.15 Apply speaking and active listening skills.

2.3 Written Communication Skills

2.31 Recognize elements of written and electronic

communication (spelling, grammar, and formatting).

TEKS

§130.208 (c) (7)(A) evaluate public health issues related to asepsis, isolation, immunization, and quarantine;

§130.208 (c) (7)(D) investigate diseases that threaten world health and propose intervention strategies; and

§130.208 (c) (7)(E) develop a plan for personal health and wellness.

Texas College and Career Readiness Standards

Science Standard

I. Nature of Science: Scientific Ways of Learning and Thinking

A. Cognitive skills in science

1. Utilize skepticism, logic, and professional ethics in science.
2. Use creativity and insight to recognize and describe patterns in natural phenomena.
3. Formulate appropriate questions to test understanding of natural phenomena.
4. Rely on reproducible observations of empirical evidence when constructing, analyzing, and evaluating explanations of natural events and Processes

B. Scientific Inquiry

1. Design and conduct investigations in which hypotheses are formulated and tested.

II. Foundation Skills: Scientific Applications of Mathematics

D. Research Skills / Information literacy

1. Use search engines, databases, and other digital electronic tools effectively to locate information.
2. Evaluate quality, accuracy, completeness, reliability, and currency of information .

Transmission of Pathogens Lab Investigation

Purpose

In this lab you will show how a disease may be spread throughout a population. One student will be the original carrier of a “disease.” This disease is perfectly harmless, if handled properly. You will carry it in a test tube, rather than in your body. The original carrier will make contact with several students in the class who will then make contact with others. All the students will be tested to see who has become infected.

Background Information

Materials

Disposable pipettes with a bulb
Test tubes with lids
Phenolphthalein (indicator)
0.001 M HCl (stock solution for non-carriers)
0.1 M NaOH (stock solution of the carrier)
Safety goggles
Lab apron
Gloves
Biohazard containers
Surface disinfectant
Paper towels

Procedure

Strong acids and bases can cause bad burns, especially to eye membranes. They can also damage clothing, floor tiles, tables, etc. Therefore, strong acids and bases must be handled carefully, and all safety precautions must be followed.

Phenolphthalein is a pH indicator that turns red or pink in the presence of a basic solution.

1. Wash your hands and put on gloves and goggles.
2. Assemble equipment and materials.
3. Prepare the work area.
4. Choose a partner at random.
5. Remove one pipette full of solution from your test tube and empty it into your partner's. Repeat for your partner.
6. Place the lid on your test tube and gently invert the test tube several times.
7. In the data table (Round 1) record the name of the person with whom solutions were exchanged.
8. Repeat steps 4 – 7 two more times, each time with a different partner.

9. When solutions have been exchanged with three different partners, add a few drops of phenolphthalein to your test tube to see if you are “infected” with the “disease.” If the solution turns red you are “infected.” If the solution remains clear, you are “not infected.”
10. Complete the class data table using information from others in your class.
11. Wash and rinse all test tubes and caps thoroughly with soap and water.
12. Return all stock solutions to their proper location in the lab.
13. Clean the work area with surface disinfectant. Remove goggles and gloves, and wash your hands.

Data

Complete the Data Table.

1. Using an asterisk (*), mark those students’ names in the data table whose test tube solutions turned red (positive).
2. Trace the transmission of the infection to each student testing positive. Can you determine who the original carrier was? Add a drop of phenolphthalein to the stock solutions to see if you are right.
3. Trace the transmission to see who infected you.

Conclusion

1. What is the maximum number of people that could test positive after three rounds of contact?
2. How many rounds would it take for everyone in the class to become “infected”?
3. Was there any outward indication of those who were “infected”?
4. Explain why the lack of outward signs of disease could be so dangerous.
5. Predict how a transmission could be prevented.

| Data Table | | | | | | | | | |
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[illegible]

Oral Presentation Rubric

Student: _____ Date: _____

| Scoring criteria | 4. Excellent | 3. Good | 2. Needs Some Improvement | 1. Needs Much Improvement | N/A |
|--|-----------------|------------|---------------------------------|---------------------------------|-----|
| Clearly and effectively communicates the main idea or theme. | | | | | |
| Self-confident and clearly expresses ideas. | | | | | |
| Answers questions with well thought out responses. | | | | | |
| Holds the audience's attention and maintains eye contact. | | | | | |
| Visual aids are clear and add to the presentation. | | | | | |

NOTE: N/A represents a response to the performance which is "not appropriate."

Laboratory Investigation Rubric

Student: _____

Course: _____

Date: _____

| Scoring Criteria | 4. Excellent | 3. Good | 2. Needs Some Improvement | 1. Needs Much Improvement | N/A |
|---|-----------------|------------|---------------------------------|---------------------------------|-----|
| Problem is appropriately identified. | | | | | |
| Problem is precise, clear, and relevant. | | | | | |
| Association between the problem and the predicted results is direct and relevant. | | | | | |
| All variables are clearly operationalized. | | | | | |
| Demonstrates comprehension scientific concepts and vocabulary. | | | | | |
| All significant data is measured. | | | | | |
| Data is recorded effectively and efficiently. | | | | | |
| Data table is well designed to the task requirements. | | | | | |
| Conclusion relates directly to the hypothesis. | | | | | |

| | | | | | |
|---|--|--|--|--|--|
| Conclusion has relevancy in resolution of the original problem. | | | | | |
| Conclusion relates the study to general interest. | | | | | |